“Hits” (not “Discussion Posts”) predict student success in online courses: A double cross-validation study

Cheryl Ramos *, Errol Yudko

Department of Psychology, University of Hawai‘i Hilo, 200 West Kawili Street, Hilo, HI 96720, United States

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Abstract

The efficacy of individual components of an online course on positive course outcome was examined via stepwise multiple regression analysis. Outcome was measured as the student’s total score on all exams given during the course. The predictors were page hits, discussion posts, and discussion reads. The vast majority of the variance of outcome was accounted for by total page hits. Participation in discussion had little to no effect on performance as measured by outcome on exams. The results were double cross-validated with a sample chosen from another class. There was no shrinkage, indicating that the equations derived from the two samples were very reliable.

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1. Background

The demand for online university courses continues to grow. Each year new online courses and programs become available from universities and colleges across the country. The traditional classroom instruction model continues to be challenged as the demand for innovative and technologically advanced course delivery increases. In response to the growing interest in distance education, research on distance education has emerged in several areas.

One area of study has focused on comparing student outcomes in online versus face-to-face instruction. Research has found that a course offered online has similar student outcomes (e.g. satisfaction, learning) as when the class is offered in a traditional classroom (Allen et al., 2004; Chernish, DeFranco, Lindner, & Dooley, 2005; Neuhauser, 2002; Spooner, Jordan, Algozzine, & Spooner, 1999).

A second area of study has focused on various types of interactions that occur in the online learning environment including learner–learner, learner–teacher, learner–content, and learner–interface interaction (Hillman, Willis, & Gunawardena, 1994; Moore, 1989). Considerable attention has been given to learner–learner interaction
in the online learning environment including the examination of learner–learner online communication patterns (Knowlton, 2003), the development of online learning communities as a result of positive learner–learner interaction (Wang, Sierra, & Folger, 2003) and the use of discussion boards to promote learner–learner interaction (King, 2001; Stow, 2005; Suler, 2004; Woods & Ebersole, 2003). With respect to learner–teacher interaction, the literature highlights the importance of frequent and timely teacher-to-learner communication as a means of increasing course performance and student satisfaction (Newlin & Wang, 2002). With respect to learner–content interaction, several studies provide examples of course design components, including the use of course management tools (e.g. email, discussion boards, chat rooms), active and collaborative course projects, and the use of various modes of delivering course content including the use of text, audio, and streamed-video (Johnson, 2003; Notar, Wilson, & Ross, 2002). Results emphasize the importance of organized and high-quality course content (Reisetter & Boris, 2004; Tricker, Rangecroft, & Long, 2001) and the cautious and selective use of multimedia course delivery so as not to overwhelm online students and their computer/internet resources (Daub et al., 2006; Sadik & Reisman, 2004). Students' perceptions of learner–content interaction was a significant predictor of academic success (Sadik & Reisman, 2004). Finally, in regards to learner–interface interaction, our personal experience and that of others indicates that proficiency in the use of technology and the course management platform on which an online course is run is critical to the success of both the online learner and the online teacher (Hillman et al., 1994). Positive learner–interface interaction impacts all other forms of online communication and the overall course experience.

A third area of study has addressed the relationship between different course communication tools (such as email, chatrooms and discussion boards) and student outcomes (i.e. final course grades). Email is the most frequently used asynchronous form of learner–teacher communication in an online course. Email is a quick and easy means for transmitting information, questions, and answers between learner and teacher about course requirements and course content. Chatrooms are a frequently used synchronous method of learner–teacher communication in an online course. Chatrooms simulate the traditional classroom and allow for real-time group discussion. Discussion boards are used as a means for engaging students in discussion about course content and promoting critical thinking, problem solving, and knowledge construction (Marra, Moore, & Klimczak, 2004).

Students who use email and online course chatrooms regularly had higher final grades in the class (Hiltz, 1993; Kember, Lai, Murphy, & Yuen, 1992; Wang & Newlin, 2000). The relationship between the use of discussion boards and student outcomes is mixed. Wang and Newlin (2000) found that final grades in an online class were correlated with the number of discussion board postings read and written by students during the semester. However, in other studies, students reported that discussion board postings were of little value and did not contribute to their learning of course content (Sadik & Reisman, 2004; Reisetter & Boris, 2004). Considering the amount of time and energy that is required to develop, manage, and maintain various online course components, particularly discussion boards, it is essential that their value in relation to student learning be examined more closely.

In the current study, we address the issue of the efficacy of individual course components on positive course outcome via stepwise multiple regression analysis.

2. Methods

2.1. Participants

The research participants were all students attending a small liberal arts college in Hawaii. The ethnic breakdown of the university that year was 38% Caucasian, 25% Asian, 22% Pacific Islander, 11% mixed ancestry, 1% African American, 1% Latino, and 1% American Indian. The ethnic breakdown of the students who participated in the courses under study was similar to that of the university overall. Two courses were chosen for study. The initial validation study was performed on a Community Psychology course comprised of 67 students. The cross validation was performed on a course in Psychopharmacology which was comprised of 52 students.

2.2. WebCT measures

Reads. Reads were defined as the frequency in which each student viewed the discussion postings of other students or the course instructor.
Posts. Posts were defined as the frequency in which each student posted to the class discussions.

Hits. Hits were defined as the frequency in which each student viewed the content pages at the class site.

Total quiz scores. For the Psychopharmacology class, total quiz score was calculated by adding one point for each of the multiple choice questions that a student gave the correct response to across all of the quizzes taken in the course. For the Community Psychology class, total quiz score was calculated adding one point for each of the multiple choice, matching, and short-answer essay questions that a student gave the correct response to for the midterm and final exams taken in the course. Total quiz score did not necessarily reflect the final grade the student received for the class. Final grades were based on total points earned in the course including quiz scores, assignments, and project points (for Community Psychology course).

Community Psychology. Community Psychology is an upper division course offered to psychology and non-psychology students who complete the prerequisite Psychology 100 (Survey of Psychology) course. The course was taught online via WebCT during the 16-week Spring 2004 semester and in two four-week summer sessions in 2004 and 2005. The course materials included a syllabus, daily assignments, course projects, midterm exam and a final exam. Course material was presented in the form of written text, video lectures, PowerPoint slides, and links to relevant internet resources. Data collected from these three separate course was combined for the purpose of the current analysis.

Each week during the Spring semester, the instructor posted a topic module relating to a weekly topic. Topics covered included (1) history of community psychology, (2) research methods in community psychology, (3) prevention, (4) social change, and others. During the summer sessions, more than one topic module was provided each week. The topic module included a written lecture (which included an overview of the topic, readings, and assignments for the topic module), a video lecture, and related PowerPoint slides. Assignments included discussion board postings and/or the writing of short papers for which students were required to respond directly to a question posed by the instructor. Students earned points for their discussion postings and papers. In addition to the topic module assignments, students were required to complete three course projects: (1) community interview, (2) community survey, and (3) community service. Students completed an online midterm and final exam consisting of multiple-choice, matching, and short-answer essay questions.

Psychopharmacology. This was a six-week summer course provided entirely online under the WebCT format. Data collected from two separate courses (taught one year apart) was combined for the purpose of the current analysis. The content of the two courses was identical. Course material was presented in the forms of video lectures combined with power point presentations, links to external sites that contained content relevant to the course, and reading assignments. The course focus was on the drug methamphetamine, but several topics relating to that drug were explored, including (1) the history of recreational drug taking, enforcement, and treatment; (2) neurotransmission, drug effects, and drug action; (3) drug use and forensic psychology; (4) misconceptions, drug use and the neonate, drug use and aggressive behavior; (5) reward, tolerance, diagnosing abuse and dependence; and (6) modern approaches for treating drug dependence.

Class discussion was interactive. Each week the instructor posed a question that related to the reading material that would be covered that week. Students were required to respond either directly to that question, to the responses of other students, or to follow-up postings of the instructor. Students were required to post a minimum of twice each week. These postings were responsible for approximately 13% of the student’s grade.

After viewing the course materials and posting to the class discussion the students were required to take a weekly quiz. A total of 77 questions were given over the six-week period. Each was worth one point.

2.3. Analysis

2.3.1. Cross-validation

In multiple regression, the multiple correlation coefficient (R) is used as a measure of how well the regression equation fits the population from which the sample was drawn. With samples of small size, sampling bias can reduce the reliability of how well R of the sample predicts R of the population. Cross-validation is a procedure used for the empirical testing of the reliability of a multiple regression equation. This is achieved by developing an equation from data collected from one sample (the screening sample) and then using that equation to predict outcomes for another sample (the calibration sample). The cross-validated R is the correlation between the values predicted for the calibration sample and the actual values of the calibration sample.
In the current study, the students from the Community Psychology course were treated as the screening sample and those from the Psychopharmacology course the calibration sample. Stepwise multiple regression was conducted via SPSS version 14.0. The results of the analysis were used to derive a multiple regression equation for the screening sample. This equation was then used to calculate the predicted total quiz scores for each of the students who made up the calibration sample. Those predicted scores were then correlated with the empirically obtained scores from that same sample. The resultant cross-validated $R$ is an index of how well the equation derived from the screening sample predicted the scores of the calibration sample. If the cross-validated $R$ is significantly smaller than the multiple correlation coefficient (shrinkage) then we can conclude that reliability was low.

2.3.2. Double cross-validation

In double cross-validation the screening sample and the calibration sample are switched and the analysis redone. In the current study the Psychopharmacology students were treated as the screening sample and the Community Psychology course the calibration sample. The steps involved in calculating the cross-validated $R$ were otherwise identical to those described above.

3. Results

3.1. Regression analysis of the outcomes in the community psychology course

Table 1 presents descriptive statistics for the total of the quiz scores, the number of page hits, discussion posts, and discussion reads for the 67 students who were enrolled in Community Psychology. Table 2 presents Pearson’s product–moment correlation coefficients for the same variables. As can be seen from Table 2, neither reads nor posts correlated significantly with quiz scores. However, page hits were positively correlated with quiz score.

Exploratory data analysis was conducted to check for violations of the assumptions of multiple regression analysis. The error term was approximately normally distributed with a mean of 0. Evaluation of tolerance, VIF, eigenvalues, and condition index indicated that multicollinearity was not a problem.

Stepwise multiple regression was conducted to determine which of the independent variables (number of page hits, discussion posts, and discussion reads) predicted the dependent variable, total of quiz scores. Only one independent variable met the criteria for entry into the model, page hits. Discussion posts (when included $\beta = 0.066$) and discussion reads (when included $\beta = 0.076$) did not predict total of quiz scores. The model summary is presented in Table 3.

Table 1
Descriptive statistics for students enrolled in community psychology

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quiz score</td>
<td>79.33</td>
<td>21.57</td>
<td>67</td>
</tr>
<tr>
<td>Reads</td>
<td>295.58</td>
<td>226.36</td>
<td>67</td>
</tr>
<tr>
<td>Posts</td>
<td>13.20</td>
<td>11.82</td>
<td>67</td>
</tr>
<tr>
<td>Page hits</td>
<td>454.46</td>
<td>260.44</td>
<td>67</td>
</tr>
</tbody>
</table>

Table 2
Pearson’s correlation coefficients for students enrolled in community psychology

<table>
<thead>
<tr>
<th></th>
<th>Quiz scores</th>
<th>Reads</th>
<th>Posts</th>
<th>Hits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quiz scores</td>
<td>1.000</td>
<td>.197</td>
<td>−.025</td>
<td>.277*</td>
</tr>
<tr>
<td>Reads</td>
<td>1.000</td>
<td>.155</td>
<td></td>
<td>.508***</td>
</tr>
<tr>
<td>Posts</td>
<td>1.000</td>
<td></td>
<td>.142</td>
<td></td>
</tr>
<tr>
<td>Hits</td>
<td>1.000</td>
<td></td>
<td></td>
<td>1.000</td>
</tr>
</tbody>
</table>

*p < 0.05. **p < 0.001.
Page hits accounted for 7.6% of the total variance of total of quiz scores. ANOVA revealed a statistically significant result (see Table 4), $F(1, 65) = 5.384; p < 0.05$. The beta weight was positive (see Table 5).

Thus, the regression equation obtained was (total of quiz scores) $= (0.023) \times$ (number of page hits) + 68.923.

### 3.2. Regression analysis of the outcomes of the psychopharmacology course

Table 6 presents descriptive statistics for the total of the quiz scores, the number of page hits, discussion posts, and discussion reads for the 52 students who were enrolled in the Psychopharmacology course. Table 7 presents Pearson’s product–moment correlation coefficients for the same variables. Contrary to what we found in the Community Psychology course, there were significant positive correlations between reads, posts, and page hits with quiz scores in the Psychopharmacology course. However, as can be seen from the regression analysis described below, the vast majority of the variance was due to page hits.

| Quiz score | 62.96 | 14.59 | 52 |
| Reads | 366.61 | 200.78 | 52 |
| Posts | 16.57 | 13.9 | 52 |
| Page hits | 324.30 | 243.51 | 52 |

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| Quiz scores | 1.000 | .286* | .311* | .479*** |
| Reads | 1.000 | .571*** | .421*** |
| Posts | 1.000 | .451*** |
| Hits | 1.000 | .491*** |

*p < 0.05. **p < 0.01. ***p < 0.001.
Exploratory data analysis was conducted to check for violations of the assumptions of multiple regression analysis. The error term was approximately normally distributed with a mean of 0. Evaluation of tolerance, VIF, eigenvalues, and condition index indicated that multicollinearity was not a problem.

Stepwise multiple regression was conducted to determine which of the independent variables (number of page hits, discussion posts, and discussion reads) predicted the dependent variable, total of quiz scores. As we observed for students enrolled in the community psychology course discussed above, only one independent variable met the criteria for entry into the model, page hits. Discussion posts (when included $\beta = 0.119$) and discussion reads (when included $\beta = 0.102$) did not predict total of quiz scores when page hits was included in the model. The model summary is presented in Table 8.

3.3. Cross-validation study

A cross validation study was conducted to determine the stability of the observed regression weights for the equation described above. In this analysis, the students from the Community Psychology course were used as the screening sample and the students from the Psychopharmacology course were used as the calibration sample. Fifty-two students from the Psychopharmacology course were used to cross validate the equation derived from the Community Psychology students. The correlation coefficient for the actual observed scores of the 52 students enrolled in the Psychopharmacology course and the scores predicted by the regression equation that was developed with data from the Community Psychology course, was calculated to be 0.479, significant at the 0.001 level. The $R$-value for the regression using students from the Psychopharmacology course was calculated to also be 0.479 (see Table 8), indicating that there was no shrinkage.

3.4. Double cross-validation study

To further support the stability of the observed regression weights a double cross validation study was conducted. Stepwise multiple regression was conducted for the set of 52 students enrolled in the psychopharmacology course. Page hits accounted for 23.0% of the total variance of total of quiz scores (see Table 8). ANOVA revealed a statistically significant result (see Table 9), $F(1, 50) = 14.908; p < 0.0001$. The beta weight was positive (see Table 10).

<table>
<thead>
<tr>
<th>Table 8</th>
<th>Model summary for students enrolled in psychopharmacology</th>
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<tbody>
<tr>
<td>R</td>
<td>$R^2$</td>
</tr>
<tr>
<td>0.479</td>
<td>0.230</td>
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</table>

<table>
<thead>
<tr>
<th>Table 9</th>
<th>ANOVA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sum of squares</td>
<td>df</td>
</tr>
<tr>
<td>Regression</td>
<td>2495.71</td>
</tr>
<tr>
<td>Residual</td>
<td>8370.20</td>
</tr>
<tr>
<td>Total</td>
<td>10865.92</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 10</th>
<th>Results from regression analysis for students enrolled in psychopharmacology</th>
</tr>
</thead>
<tbody>
<tr>
<td>$B$</td>
<td>SE</td>
</tr>
<tr>
<td>Intercept</td>
<td>53.645</td>
</tr>
<tr>
<td>Number of page hits</td>
<td>.029</td>
</tr>
</tbody>
</table>

***$p < 0.001.$
Thus, the regression equation obtained for the Psychopharmacology students was (total of quiz scores) \(= (0.029) \times \text{(number of page hits)} + 53.645\).

The correlation coefficient for the actual observed scores of the 67 students from the Community Psychology course, and the scores predicted by the regression equation that was derived from Psychopharmacology students, was calculated to be 0.277, significant at the 0.05 level. The \(R\)-value was calculated to also be 0.277, indicating that there was, again, no shrinkage.

4. Discussion

In the present study we explored two hypothesis: (1) Which, if any, of three predictor variables (page hits, discussion reads, or discussion posts) accounted for success in class (as measured by total quiz score)? and, (2) Does the resulting regression equation reliably predict outcome? The answer to the first question was that page hits was the only predictor of success. The answer to the second was that page hits are a very reliable means of predicting success.

Stepwise multiple regression was conducted to determine which, if any, of the three variables predicted outcome. For the community psychology course the only significant predictor was page hits, which accounted for only 7.6% of the total variance. This finding suggests that while page hits were predictors of success, and discussion reads and posts failed to predict success, there were other variables important to success that we failed to account for. These could be motivation, internet/computer competency, or other individual differences that we did not measure in the current study.

When the students in the psychopharmacology course were examined similar results were observed. Once again page hits were the only predictor of success. However, in this case they accounted for 26% of the total variance. One possible explanation for how much more variance was predicted by this variable in this population has to do with the novelty of the information presented in this type of class. In the Community Psychology course it can be expected that students will bring a great deal of information with them from previous classes that may affect outcome. There may indeed be a high level of variability in the breadth and depth of that knowledge. However, the Psychopharmacology course was grounded in physiological psychology, an area that few psychology majors have a great deal of experience with. Thus, the students could have been much more similar to each other in terms of their knowledge upon entering the class.

The results of our cross-validations have very important consequences for our understanding of those aspects of online courses that contribute to the learning of course material. These two courses, Community Psychology and Psychopharmacology are very different from each other. They had different scopes, were taught by different instructors who had different training, and had different students. Even so, we found the same significant predictor for each course. More importantly, we found the same lack of ability for participation in discussion to predict success. Regression equations derived from each of the courses adequately predicted success in the other course. These empirical results are consonant with findings of Wang and Newlin (2000) who found that final course grades were highly correlated with the number of hits to the course homepage and with student self-report of the lack of value of discussion board postings (Reisetter & Boris, 2004; Sadik & Reisman, 2004). However, our findings contradict Wang and Newlin’s (2000) findings that course outcome was correlated with the number of discussion board postings read and written by students during the semester.

Quality, rather than quantity, of time spent in online course discussion may be a better predictor of success (Ahern & Durrington, 1996; Taraban, Maki, & Rynearson, 1999). Students who engage in online discussion have a tendency to engage in shallow discussion (Kanuka & Anderson, 1998; Thomas, 2002). Learning complex material requires that students be challenged (Vygotsky, 1978). Thus, a number of authors have discussed the importance of guided participation in online discussion (for review see Tallent-Runnels, Thomas, Lan, Cooper, & Ahern, 2006). Other important aspects of online course communication include prompt feedback from instructor to student, participation of the instructor, encouraging social interaction, the use of collaborative learning strategies (McIssac, Blocher, Mahes, & Vrasidas, 1999), and including a high number of learner–teacher and learner–learner interactions (Keefe, 2003; Wilson & Whitelock, 1998).

Participation in online discussion requires that individual students read each of the posts written by their classmates and respond to some of those posts. This requires a great commitment of time, and while such an
effort may help students to develop critical thinking skills and learn to interact with their fellows, it may also distract a student from studying the materials that are most likely to appear on the exam. These materials would have been provided in much more succinct forms in the video lectures, power-point presentations, content pages, and reading assignments that were given than in lengthy discussions with their classmates and professor. Based on our findings, it appears that the learner–content interaction is the best predictor of course outcomes. However, research with a broader range of course subjects and a larger number of courses is needed to substantiate a general claim.

References


